Посебно издание на
Geologica Macedonica, No.4

МАКЕДОНСКО ГЕОЛОШКО ДРУШТВО

ТРЕТ КОНГРЕС
на
Геолозите на Република Македонија

ЗБОРНИК НА ТРУДОВИ
-КНИГА 2-

Уредници:
Лепиткова, С. & Боев, Б.

Струга, 2016

Посебно издание на
Geologica Macedonica,№ 4

МАКЕДОНСКО ГЕОЛОШКО ДРУШТВО

ТРЕТ КОНГРЕС
на
Геолозите на Република Македонија

ЗБОРНИК НА ТРУДОВИ

-КНИГА 2-

Уредници:
Лепиткова, С. & Боев, Б.

Струга, 2016

Издавач: Македонско геолошко друштво

Главни и одговорни уредници: Проф. д-р Соња Лепиткова и
Проф. д-р Блажо Боев

Технички уредник: Доц. д-р Игор Пешевски

Печати: Печатница "2-ри Август С"-Штип

Тираж: 300 примероци

Организационен одбор на Третиот Конгрес на Геолозите на Република Македонија

Претседател: Проф. д-р Соња Лепиткова
Секретар: д-р Златко Илијовски

Технички секретар: Доц. д-р Игор Пешевски

Членови: Проф. д-р Блажо Боев
Проф. д-р Тодор Серафимовски
Проф. д-р Милорад Јовановски
Проф. д-р Орце Спасовски
Проф. д-р Војо Мирчовски
д-р Коста Јованов
м-р Флорент Чиче
Кирил Филев

Финансиска подршка:

ДПТУ „Бучим“ ДОО-Радовиш
АДОРА ИНЖЕНЕРИНГ ДООЕЛ – Скопје
Рудник “САСА” ДООЕЛ – Македонска Каменица
Градежен Институт „Македонија“ АД – Скопје
ГЕИНГ Кребс унд Кифер Интернешнл и др. ДОО – Скопје
„Мермерен комбинат“ АД – Прилеп
Простор ДОО – Куманово
„Геохидроконсалтинг“ ДООЕЛ – Скопје
„Геохидроинженеринг“ ДООЕЛ – Скопје
Хидроинженеринг ДООЕЛ– Битола
Градежен факултет – Скопје, Катедра за геотехника
„ГЕОМАП“ ДОО – Скопје
БУЛМАК ГРУП ДООЕЛ – Скопје
ЕУРОМАКС РЕСОУРЦЕС ДОО – Скопје
САРДИЧ МЦ ДООЕЛ – Скопје
МАРКОВСКИ КОМПАНИ БОРЧЕ ДООЕЛ – Битола
DIWI Македонија ДООЕЛ – Скопје
ВАРДАРГРАДБА ДОО – Скопје

MAP OF THE MOHO DISCONTINUITY OF THE REPUBLIC OF MACEDONIA

[1]Todor Delipetrov, [1]Krsto Blazev, [1]Blagica Doneva, [1]Risto Popovski

[1]University "Goce Delčev"Štip, Faculty of Natural and Technical Sciences
goran.tasev@ugd.edu.mk; todor.serafimovski@ugd.edu.mk

Abstract
Conducted researches for determination of the depth of moho discontinuity in the Republic of Macedonia dates back a long time and starts with the completion of deep seismic sounding profiles along Tetovo - Kocani and Debar - Delcevo. Using these data in the paper is an analysis of the depth of moho discontinuity depending on the amount of relief, Bouguer's anomaly and speed of neo - tectonic elevation. An discretization is made on the space with network at a distance of 5 km and each point is defined correlation coefficient and depth mojo discontinuity of the presented parameters. Based on the results, a map of moho discontinuity in the Republic of Macedonia was made. Moho discontinuity depth varies from minimum depth near Sveti Nikole about 30 km to a maximum depth of the East to the Bulgarian border and west to Albania 45 to 50 km. The research reveals an interesting pick in the result section of Ohrid - Prespa region for a very small depth of Moho discontinuity but for this point of the research is necessary to perform additional analysis given that in this area is located Ohrid - Prespa aquifer basin with a large quantity of groundwater that have affected these studies. The analysis of the map of Moho discontinuity in the Republic of Macedonia shows that this limit has the smallest depth in the part of the Vardar zone and sinking going east towards the Rhodope mass in Bulgaria and to the West to the Albanian border, also, going to south, the depth shows slight decreasing.

Key words: Moho discontinuity, depth, deep seismic sounding, map

INTRODUCTION

Knowing the deep structure of the earth's crust can be obtained using geophysical methods: seismic, gravimetric, magnetic, geothermal etc. Leading place among them in accuracy and detail are seismic methods, i.e. deep seismic sounding (DSS).
For certain common regularities and also for the increased probability and appropriate realistic interpretation of results, often are used data from complex geophysical surveys. Thus, in defining a more realistic model of the earth's crust, complex researches are use, despite seismic (deep seismic sounding) include an analysis of anomalous gravimetric and magnetic field in the investigated area.
Using various methods, with unequally accuracy, leads to different interpretation. This depends of the density of the observation points and different methodology of research, which gives differences in accuracy. For determination of the thickness of the earth's crust to Moho discontinuity, data from the DSS on the profiles Debar - Delchevo and Tetovo - Kochani were used (fig. 1 and fig. 2).
These profiles show characteristics for the thickness of the earth's crust only in the northern part of Macedonia. Also, the results for the border part are not complete, because the points of observation are rare and there is no double - sided ignition, i.e. there was no ignition from the territory of Albania.

ANALYSES OF THE PROFILES OF DEEP SEISMIC SOUNDING

On the profile Tetovo - Kochani (fig. 1) are defined two borders. Border B at the beginning of the profile and border M (Moho discontinuity). Border B as border of the consolidated crust should be taken with reserve, because of the lack of data. It shows presence of two depressions: Tetovo with the depth of 4 km and Skopje depression with the depth of 2.5 km. Border M has maximal depth of about 45 km in the most western part and toward east the depth decreased and in the area of Ovce Pole is 32 km. In Serbian

- Macedonian mass the earth's crust sinks again, which could be seen on the profile Debar - Delchevo. On the Moho discontinuity were determined many profound faults located near Skopje, St. Nikole and Kochani.

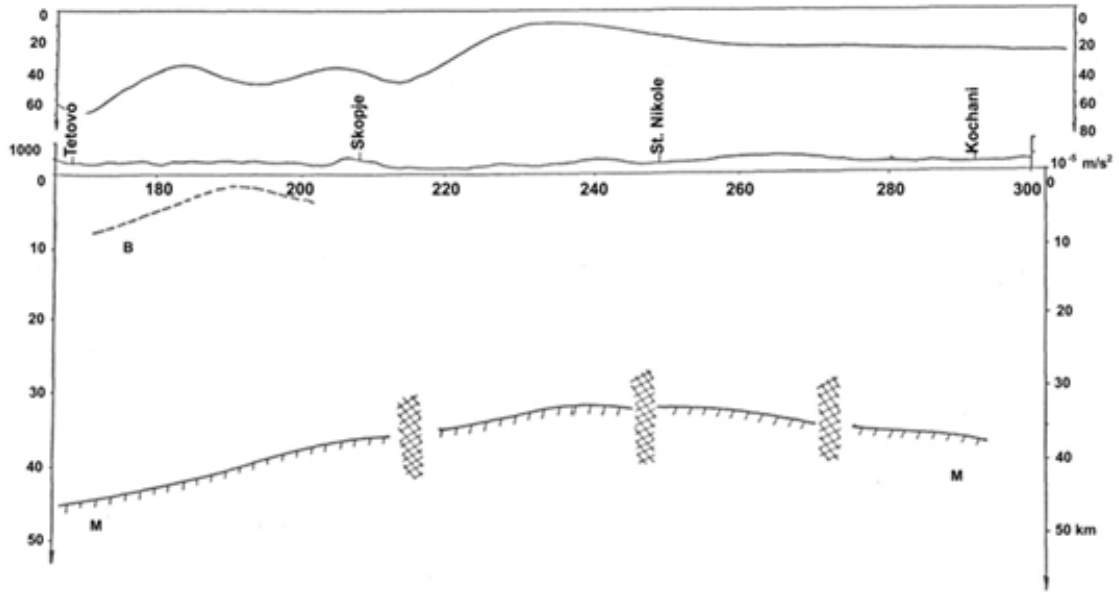

Fig. 1 *Profile of deep seismic sounding, Tetovo - Kochani*

Profile Debar - Delchevo (fig. 2) has direction east - west and cuts all structure zones on the territory of the Republic of Macedonia: Western Macedonian zone, Pelagonian massif, Vardar zone and Serbian - Macedonian mass. Heterogeneous, complex geological composition on this area has an impact on the seismic field which can be seen on the seismograms: diffraction waves, fast changes of the apparent velocities, interruption of the waves correlation, presence of large and negative apparent velocities (characteristic for steep slopes in the crust which determined fault structures) and exchange of the normal wave field with chaotic (characteristic for mosaic block structure with different physical features). In creating the depth profile were used average Vp and limit Vgr velocities estimated in the studying of these profiles. On fig 2 are marked two borders: B and M.

Border B was taken as basis of the granite layer. In other areas presents border with certain velocity in the consolidated part of the rock complex of the earth's crust. Velocities are within 5.3 - 6.6 km/s. This variation of the velocity of the border is because of the complex rock composition and different physical features. Western part of the profile is characterized with Vgr = 6.4 km/s and border B steep fall down toward west on the depth above 6 km. In the part of the Western Macedonian zone border B has syncline shape with depth of dipping to 4 km and it is perturbed with two profound faults and Vgr = 6.6 km/s. In the Pelagonian massif Border B is characterized with velocity Vgr = 6.6 km/s and depth of 2.3 km. The part of Vardar zone, in Ovce Pole, the border has velocity within Vgr = 5.3 - 5.7 km/s and it is the border of the Paleozoic metamorphic complex with depth 2.4 km. on the profile could be seen that Vardar zone is limited with two profound faults. In Serbian - Macedonian mass velocity is Vgr = 6.4 km/s and toward east the border sink to the depth of 4 km. Border M has limit velocity within 8.1 - 8.2 km/s and the depth of diping varies from 32 km near St. Nikole to 45 km toward east.

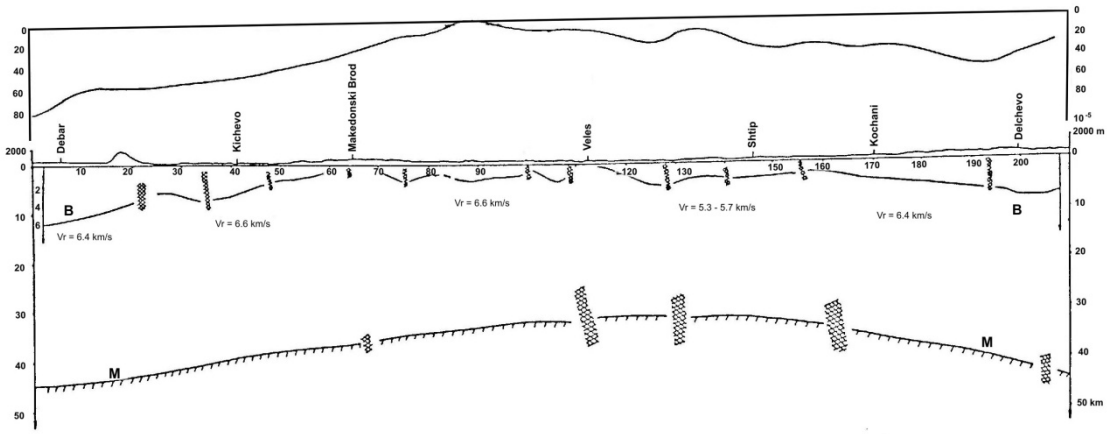

Fig. 2 *Profile of deep seismic sounding, Debar - Delchevo*

From the profile could be seen that the earth's crust is crossed with numerous profound faults which defined the borders of the geotectonic units on the territory of the Republic of Macedonia.

Bouguer's anomaly has smallest values on the western and the eastern part of the profile where the crust is thickest, and maximal values are in the central parts where the crust is thinnest.

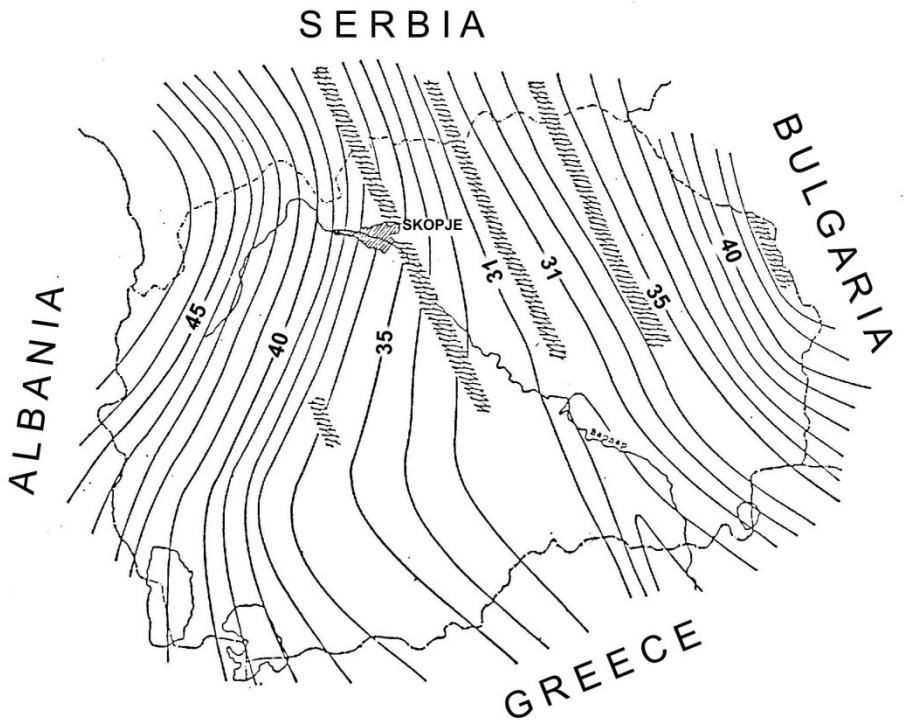

Fig. 3. *Structural map of Moho discontinuity according the data from the deep seismic sounding*

According the results from the profiles and data from the investigations about the relation between geophysical parameters and Moho discontinuity, the shown profiles define the situation of Moho discontinuity only n the northern part of Macedonia:

$$M = a + bH$$

$$M = a + \Delta g$$

where:

M - depth of Moho discontinuity
H - height of the relief
Δg - Bouguer's anomaly
a, b - coefficients of linear dependence of M from H and Δg.

Besides the above mentioned data on this map are marked the profound fault lines that divide Pelagonian massif from Western-Macedonian zone, then west marginal fault on the Vardar zone on the border with Pelagonian massif, then the central fault that divides the Vardar zone in two parts: the eastern fault on the border with Serbian-Macedonian mass and a fault which is on the border of Macedonia and Bulgaria (more in Bulgaria).

From the map could be seen that Moho discontinuity has minimum values in the part of the Vardar zone and sinks toward west (under the Pelagonian massif and the Western Macedonian zone) and toward east (under Serbian - Macedonian mass). In the southern part of Macedonia Moho discontinuity is not interpreted because of the lack of data from the deep seismic sounding (DSS).

It is interested to note that according the data from the analyses of the spreading of the seismic waves of the registered earthquakes, with determination of local hodohrones, three-layer medium is outlined in the territory of Macedonia whose parameters are not completely coincide with the parameters obtained by deep seismic sounding (DSS), but generally Mohorovichich discontinuity is located at about 40 km.

CONCLUSION

Moho discontinuity on the explored area varies in interval from 30 to 50 km. Minimal depth has in the end western part, and maximal depth has in the part of the Vardar zone.

Large differences in the depth of Moho discontinuity of such a small space is certainly one of the primary causes of strongly expressed tectonic processes that are manifested in these areas.

Investigations of this kind are the basis for defining more realistic model of the earth's crust, which basically serves a wide range of analysis in the field of geology.

REFERENCES

Boykova A., "Moho discontinuity in central Balkan Peninsula in the light of the geostatistical structural analysis", Physics of the Earth and Planetary Interiors 114, 1999 pp. 49–58

Delipetrov, T., "Correlation between crusts and subcrusts structures on the territory of Macedonia and seismicity", Doctor thesis, Stip, R. Macedonia, 1991

Delipetrov T., Petrov G., "Morphological - isostatic correlation of the profile Debar - Kriva Palanka", XII-th Yugoslavian Geological congress, Ohrid, 1990

Dragasevic T., Andric B., "Information about the results from the investigations of the structure of the Earth's crust with the method of deep seismic sounding in Yugoslavia", Skopje, 1982

Martinec Z., "The Density Contrast At the Mohorovičič Discontinuity", Geophysical Journal International, Vol. 117, Issue 2, 1994, pp. 539–544,

Skoko D., Prelogovic E., Alinovic B., "Geological structure of the Earth's crust above the Moho discontinuity in Yugoslavia", Geophysical Journal of the Royal Astronomical Society, Vol. 89, 1987, pp. 379–382.